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Software Engineering Institute

Pittsburgh, PA 15213-3890

Using the CMMI® in Acquisition Environments

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Agenda

SEI Overview

Capability Maturity Model Integration

Use of CMMI in Acquisition Environments

Conclusion

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Carnegie Mellon Univ. Major Units

Software Engineering Institute

Carnegie Institute of Technology

College of Fine Arts

College of Humanities and Social Sciences

Graduate School of Industrial Administration

H. John Heinz III School of Public Policy and Management

Mellon College of Science

School of Computer Science

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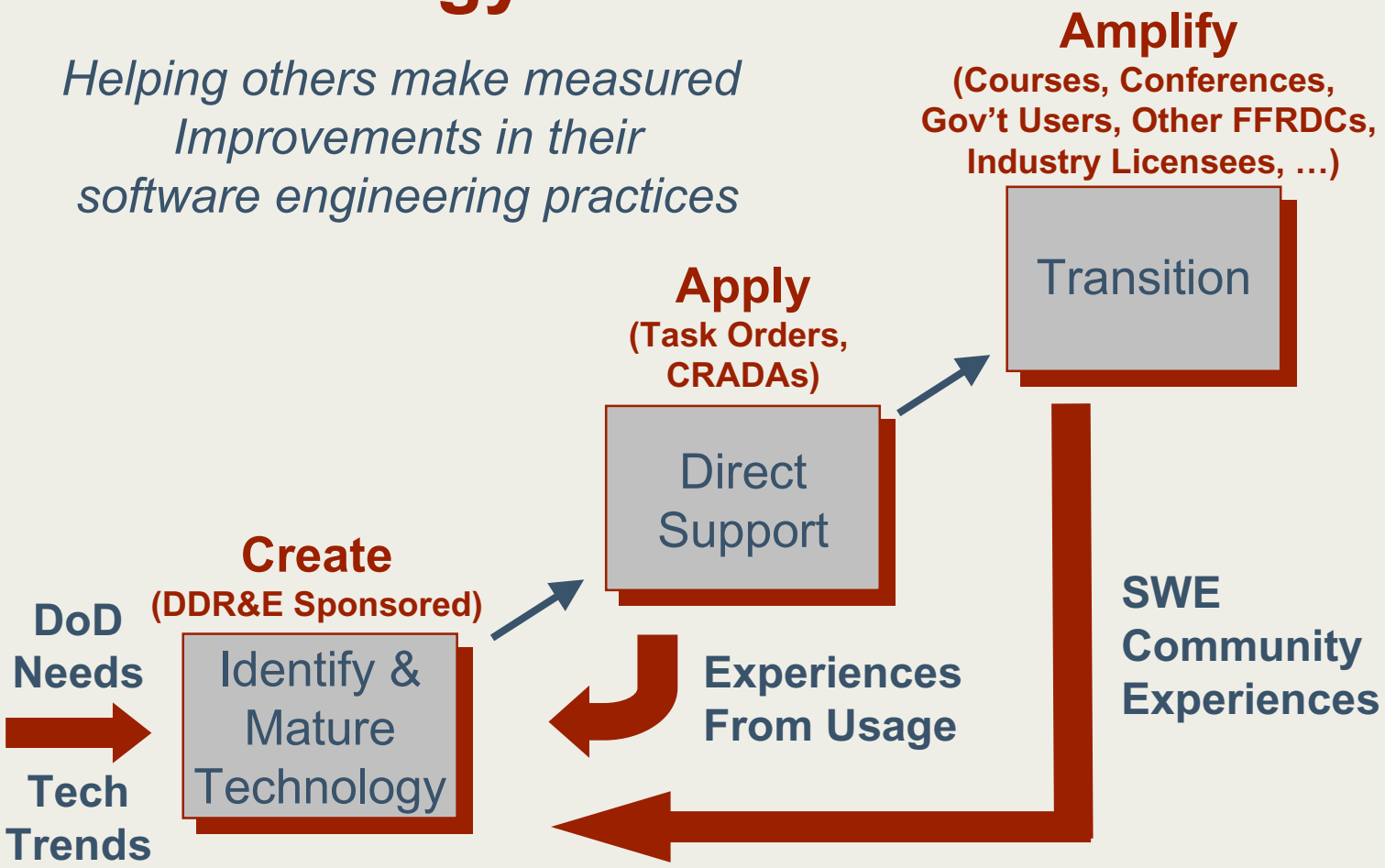
Software Engineering Institute

Software Engineering Institute

- Established in 1984 - Applied R&D Laboratory situated as a college- level unit at Carnegie Mellon University
- DoD staff ceiling (FY04): 147; Technical staff of 315
- Offices in Arlington, Va, Pittsburgh, Pa, Red Stone Arsenal, Al, Colorado Springs, Co, Frankfurt, GE
- Mission: Provide the technical leadership to improve the practice of Software Engineering so the DoD can acquire and sustain its Software Intensive Systems with predictable and improved Cost, Schedule, and Quality
- Goal: Institutionalize new and improved practices in the acquirer and developer communities

SEI Strategy

Helping others make measured Improvements in their software engineering practices



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SEI Research Agenda - *Create*

The right software delivered defect free, on cost, on time, every time

High confidence, evolvable, product lines

Integration of SIS

Survivable Systems

Performance Critical Systems

Product Line Practice

Software Architecture Technologies

Predictable Assembly with Certifiable Components

Technical Practice Initiatives

with predictable and improved cost, schedule, and quality

Capability Maturity Model Integration

Team Software Process

Software Engineering Measurement & Analysis

Management Practice Initiatives

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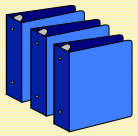
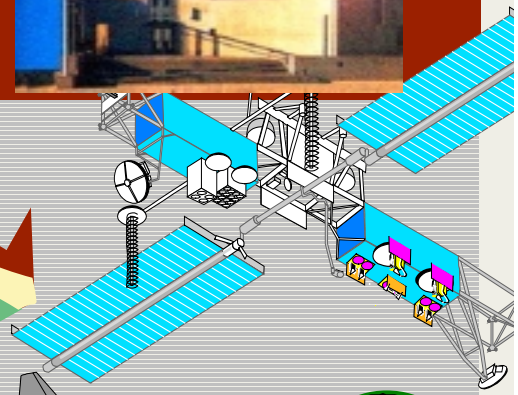
Apply

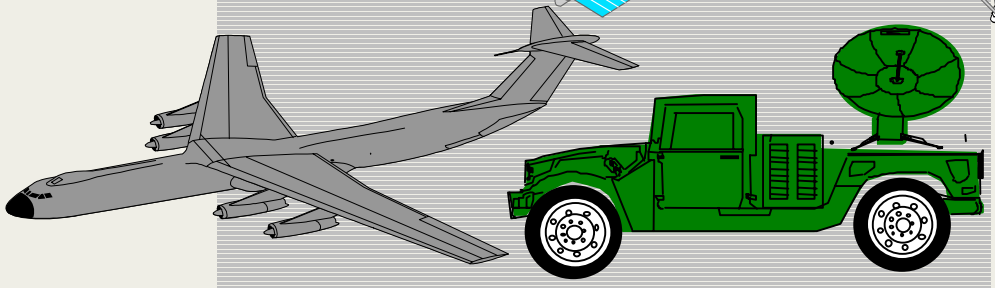


Lessons and Practices Transitioned Widely

Technical Practice Initiatives	Management Practice Initiatives

Acquisition Support Program





Direct Benefit to Acquisition Programs

Software Collaborators Network

MITRE

Universities

APL

OSD/SIS

AMCOM/SED

STSC

Aerospace

DAU

Acquisition Communities of Practice

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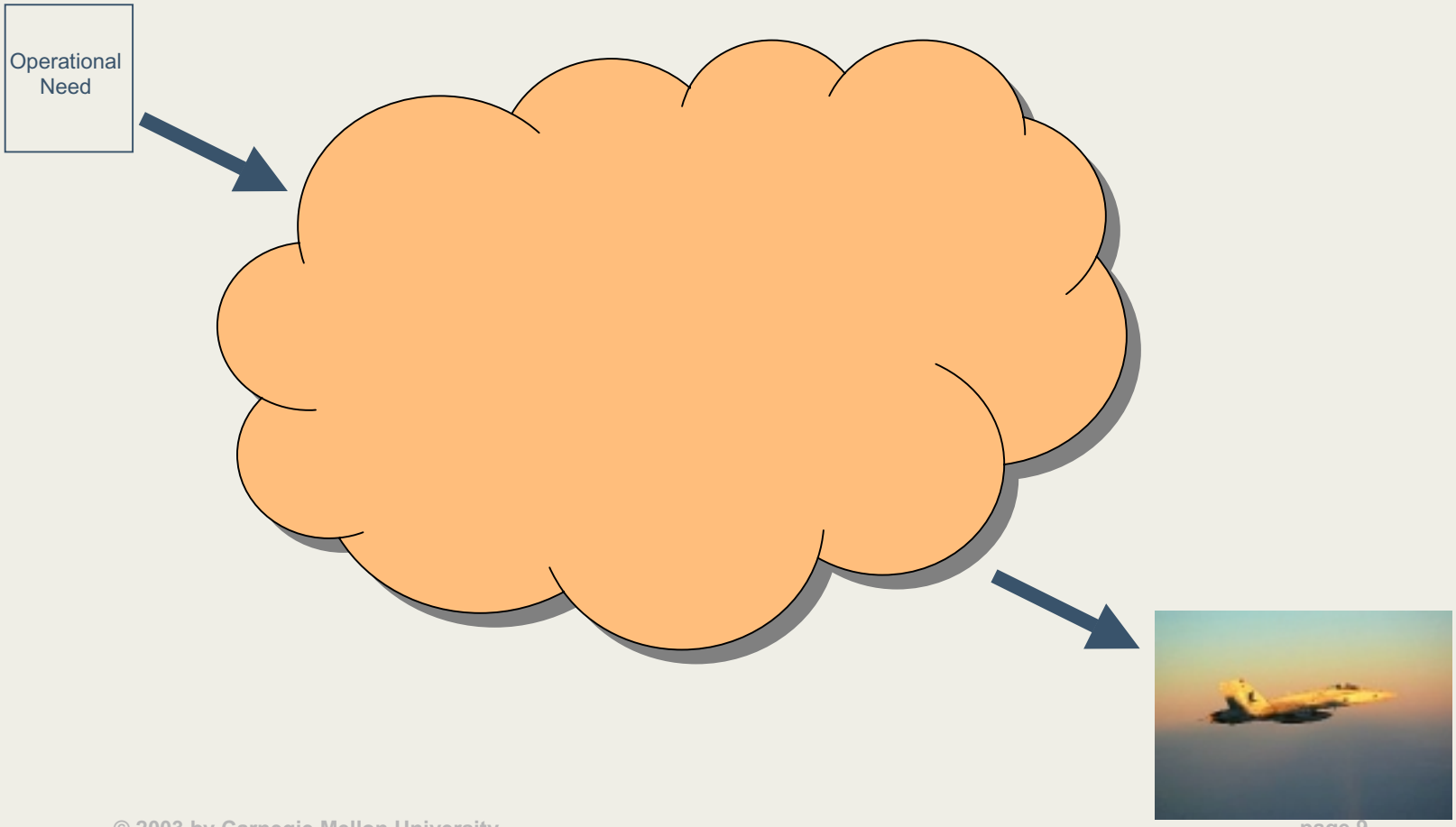
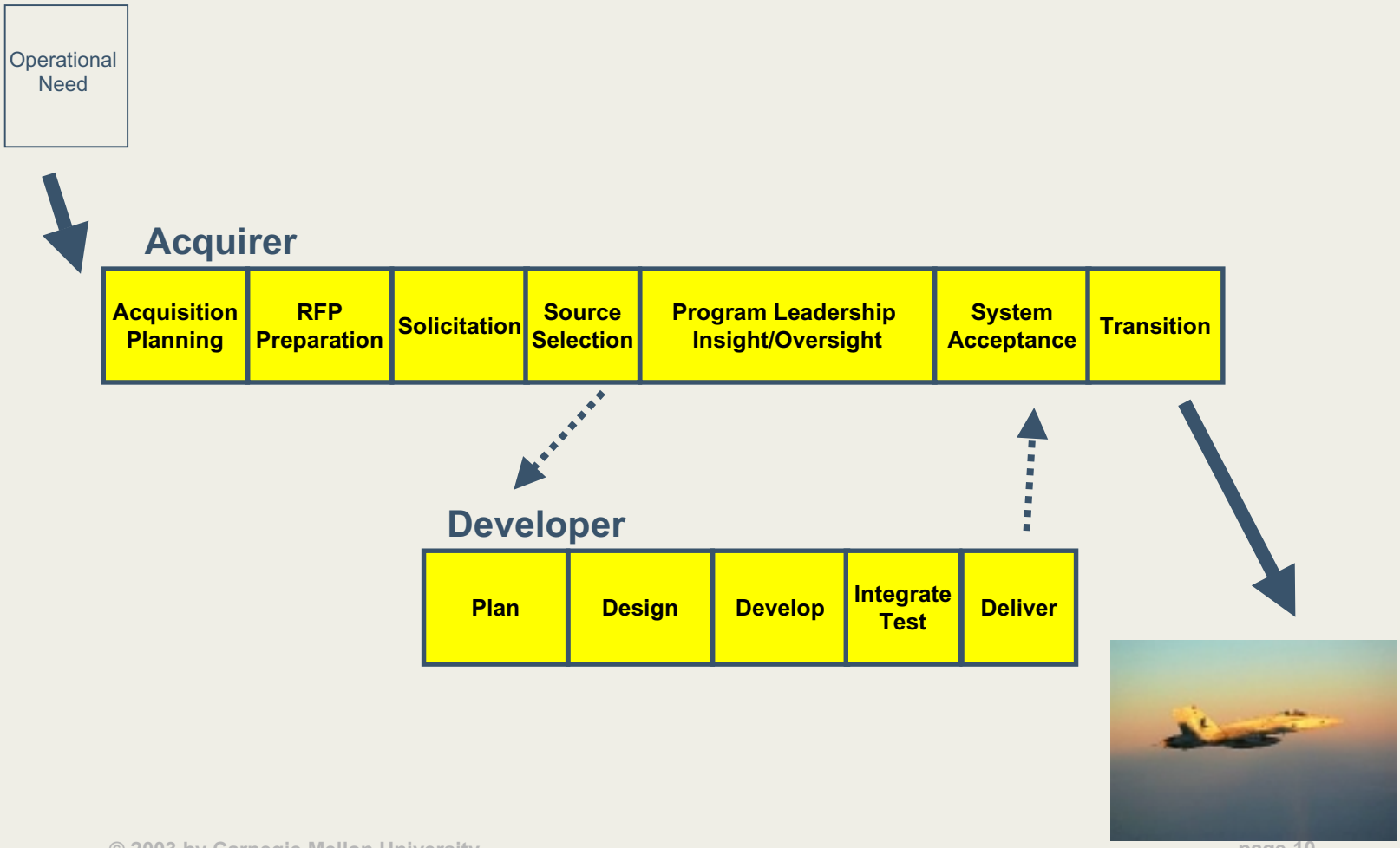
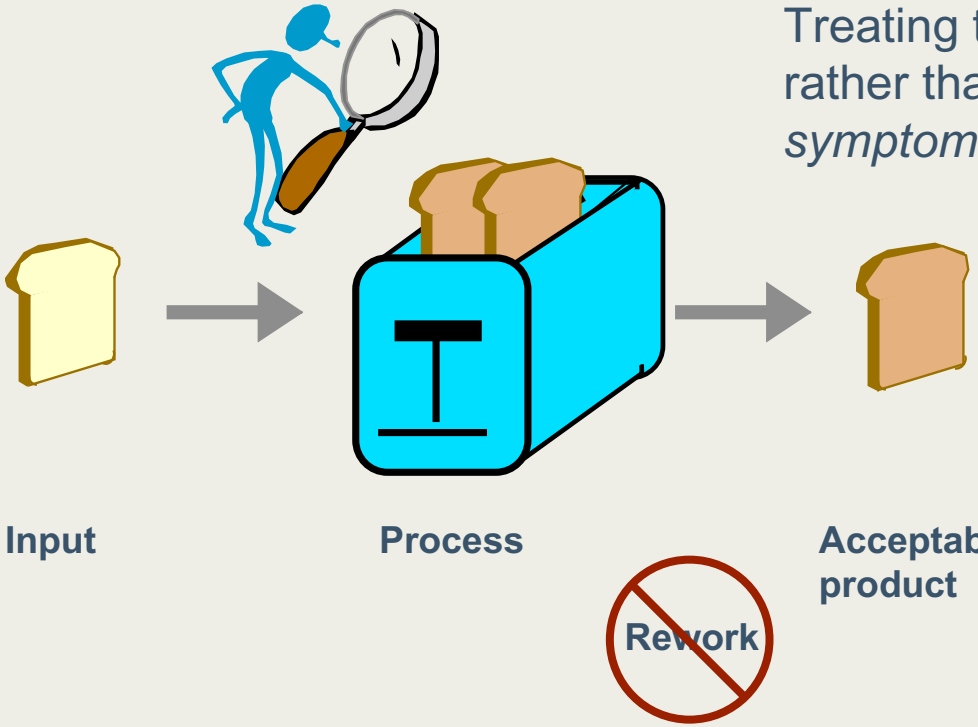
What's Important?



Defining the Processes



Improving the Processes



Treating the *cause* rather than the *symptoms.*

CMMI in a Nutshell

CMMI provides guidance for improving an organization's processes and ability to manage the development, acquisition, and maintenance of *products* or *product components*.

CMMI places proven approaches into a structure that

- helps your organization examine the effectiveness of your processes
- establishes priorities for improvement
- helps you implement these improvements

Improving processes for better products

Why Focus on Product Development?

A system's engineering approach is critical for today's extremely complex DoD systems.

- Essential for successful Spiral Development and (Evolutionary) Acquisition process

- Critical for successful Technology Insertion and Technology Transition for modern systems

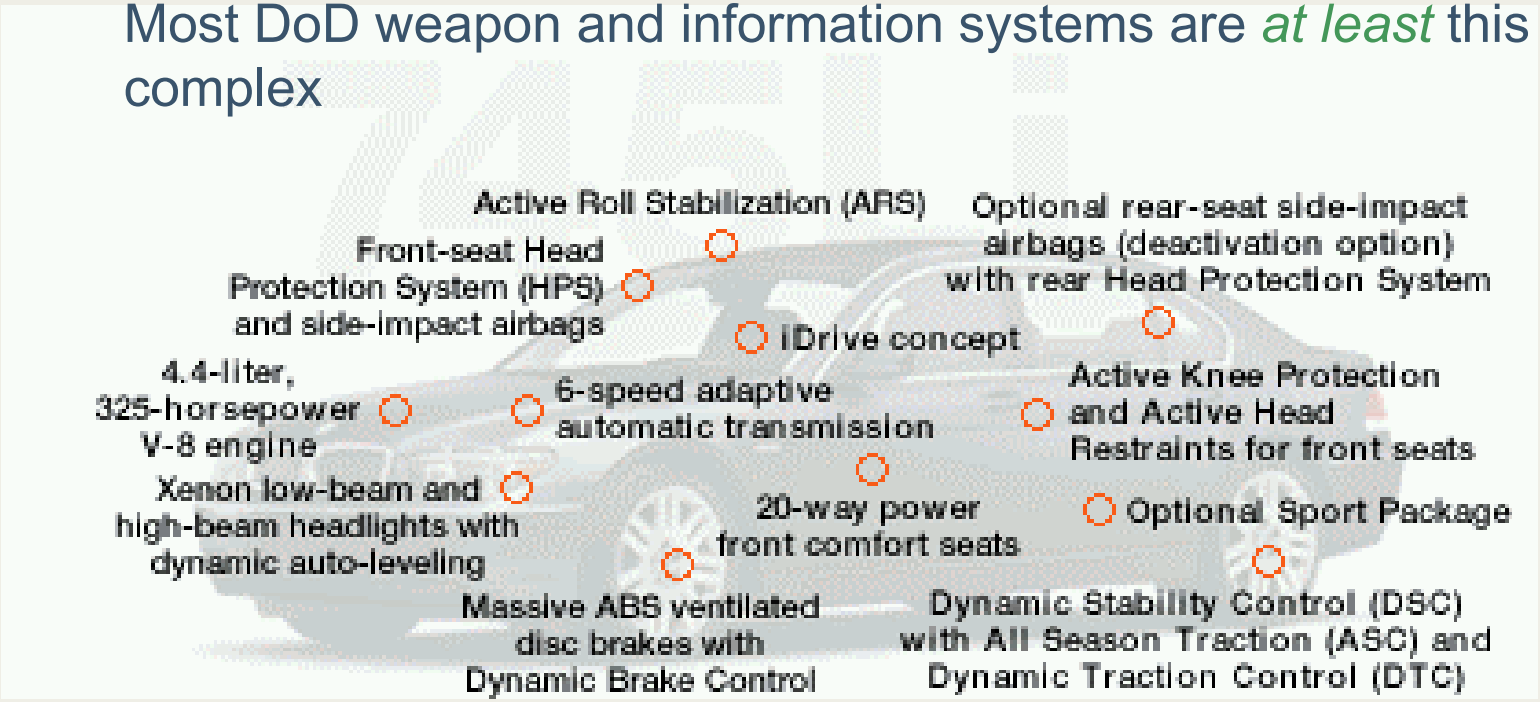
Recent example: Lack of robust systems engineering practices identified as critical factor in SBIRS-High problems
(per Lt. Gen. Brian A. Arnold, USAF, CDR, USAF/SMC, 5/6/02 Aviation Week)

CMMI implementation is major forcing function for the needed systems engineering content of today's systems

Complexity in Modern Systems

Many commercial products are the result of a complex mix of subcomponents engineered into a system

Most DoD weapon and information systems are *at least* this complex



Weapon System Complexity

T802 Engines
1231 SHP

Five Bladed Bearingless
Main Rotor

Fire Control
Radar

Composite Tail Drive Shaft

Advanced Cockpit
- Triple Redundant Flight Controls
- Digital Map
- Side Arm Controls
- Flat Panel Displays
- Helmet Mounted Display

Canted Fantail Rotor
Composite Shroud
and Blades

High Efficiency
IR Ribbon Exhaust

External
Weapons
Provision

Night Vision Pilotage System
- 2nd Generation FLIR
- Image Intensification

Internal Weapons
Bay

Advanced Target Acquisition
System
- 2nd Generation FLIR
- Eye Safe Laser
- Combat Laser
- High Resolution TV
- Aided Target Detection and Classification (ATDC)

Integrated Operational Training
and Testing Instrumentation
System (OTTIS)

Advanced Digital Avionics
- Fiber-Optic Data Busses
- Commercial Based Processors
- Digital/Modular Communications

Advanced Composite
Airframe

Stowable, Lightweight 20mm
Gun

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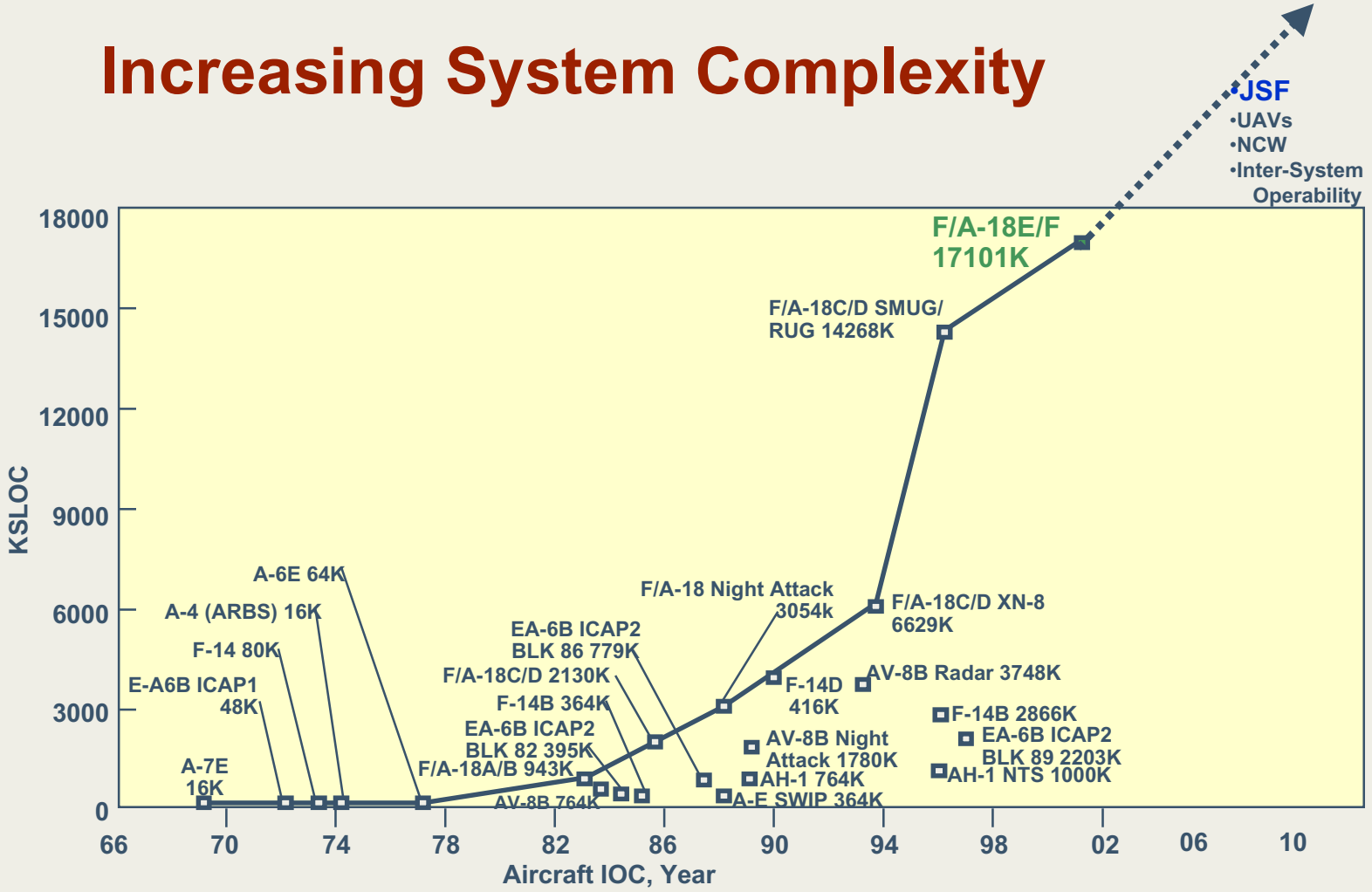
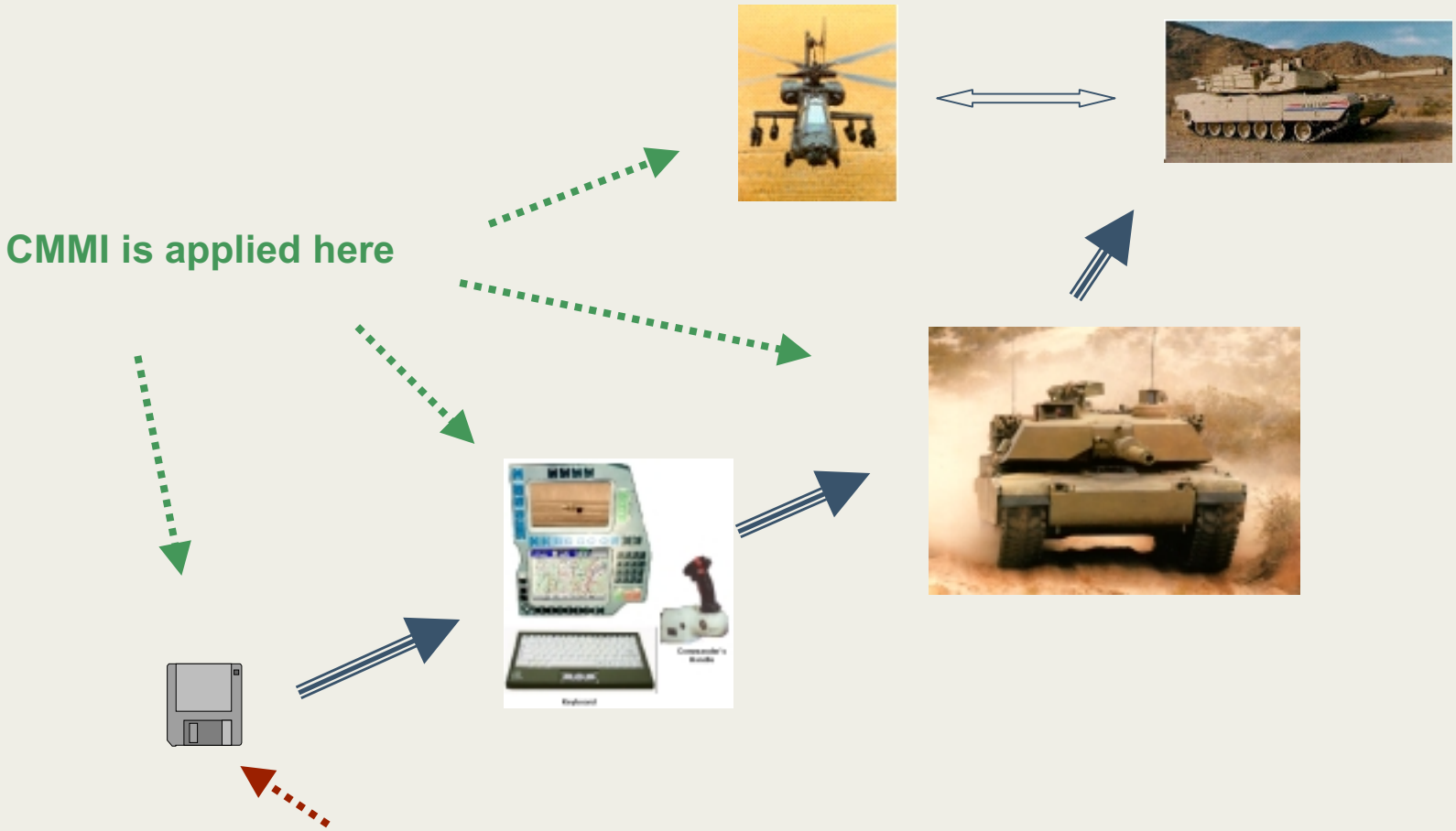
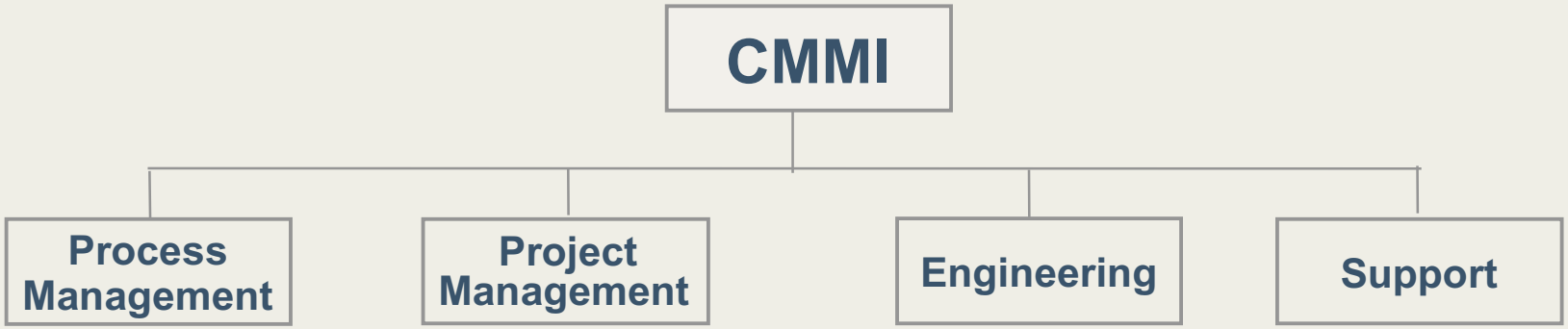
Increasing System Complexity



Focus of CMMI



CMMI SE/SW/IPPD/SS



- Organizational Process Focus
- Organizational Process Definition
- Organizational Training
- Organizational Process Performance
- Organizational Innovation and Deployment

- Project Planning
- Project Monitoring and Control
- Supplier Agreement Mgmt.
- Integrated Project Mgmt.
- Integrated Supplier Management
- Risk Management
- Quantitative Project Mgmt.
- Integrated Teaming

- Requirements Management
- Requirements Development
- Technical Solution
- Product Integration
- Verification
- Validation

- Configuration Mgmt.
- Process and Product
- Quality Assurance
- Measurement & Analysis
- Decision Analysis and Resolution
- Causal Analysis and Resolution
- Organizational Environment for Integration

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CMMI Steering Group

Bob Rassa, Raytheon (Co-chair)

Mike Nicol, USAF (Co-chair)

Ric Sylvester, OUSD(AT&L)

Dave Castellano, OUSD(AT&L)

George Desiderio, OUSD(AT&L)

Brenda Zettervall, USN

vacant, USA

Clyde Chittister, SEI

Bill Peterson, SEI

Hal Wilson, Northrop Grumman

Bob Lentz, General Dynamics

Joan Weszka, Lockheed Martin

Leroy Brown, Motorola

Linda Ibrahim, FAA

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Environment

Acquirer

Direction

Requirements

Predictable Performance

Commitment

Operational Need/Advocacy

Operational Insight

Developer

New Capabilities

Operator

Acquisition use of CMMI

Acquisition organizations can use the CMMI to:

- Help discriminate between offerors during a competitive source selection
- Help incentivize contractors to use effective practices and improve those practices after contract award
- Establish an acquisition process improvement program within the program office

Critical Questions for Source Selection

If I require everyone to be Maturity Level 3, is it a discriminator or a non-discriminator?

Is process maturity of the development teams important enough to be a discriminator, can I really find out without checking the behavior of the organization?

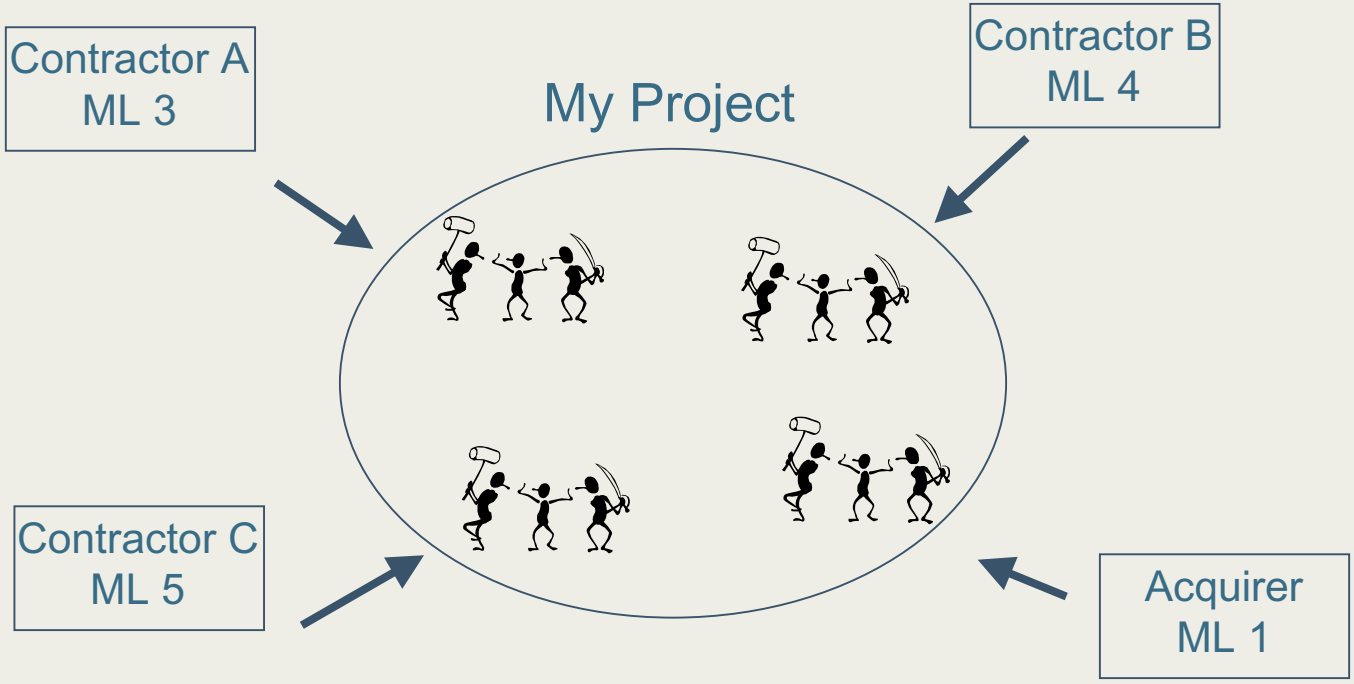
If it is important enough, do I have the time and resources to check?

What is Maturity Level 3?

If an organization is a Maturity Level 3 developer, you can expect on their *next project*:

- Team experience as captured in processes is based on organizational guidance
- Estimates are based on historical data
- The organization continually assesses their processes and products to look for improvement
- Training is defined and provided
- Stakeholders are involved
- Engineering, Management, Support, and Process related practices are defined, used, measured, and improved

Real Life



CMMI Math: 3 + 4 + 5 + 1 = ?

Implications

Maturity Levels are a good starting point

Need to ensure the team's practices are sound and that risks associated with the way the team does business are continually identified and addressed

The acquisition team's practices impact the team's overall performance

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Contract Monitoring Example

National Reconnaissance Office

Freedom's Sentinel in Space: One Team, Revolutionizing Global Reconnaissance

Mission of the NRO: Enable U.S. global information superiority, during peace through war. The NRO is responsible for the unique and innovative technology, large-scale systems engineering, development and acquisition, and operation of space reconnaissance systems and related intelligence activities needed to support global information superiority.

System Characteristics

Huge system engineering endeavors encompassing space vehicles and ground infrastructure

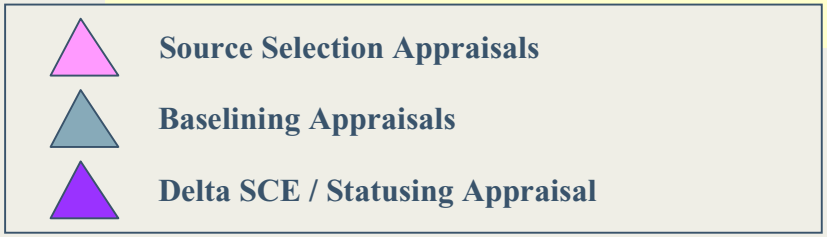
Complex software engineering and hardware responsibilities

System development pose big risks in acquisition programs

- Several Million SLOC programs
- Dispersed engineering & development locations
- Multi-contractor teams using different processes
- Combination of legacy re-use, COTS integration and new software development efforts
- Real cost and schedule constraints

Strategic Plan for Insight

Year 0:	Conduct series of source selection appraisals for all Offerors
Year 2/3 :	Conduct baselining appraisals for primes and subcontractors
Year 4:	Conduct "delta" appraisals for primes and subcontractors
Year 5 ….	Conduct "statusing" appraisals for primes and subcontractors



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Results of Contract Monitoring Appraisals

Findings from all sites combined into a set of “program findings”

- Ł 684 Program Findings (specific problems or strengths)
- (~ 55% program strengths; ~ 45% weaknesses => risk areas)

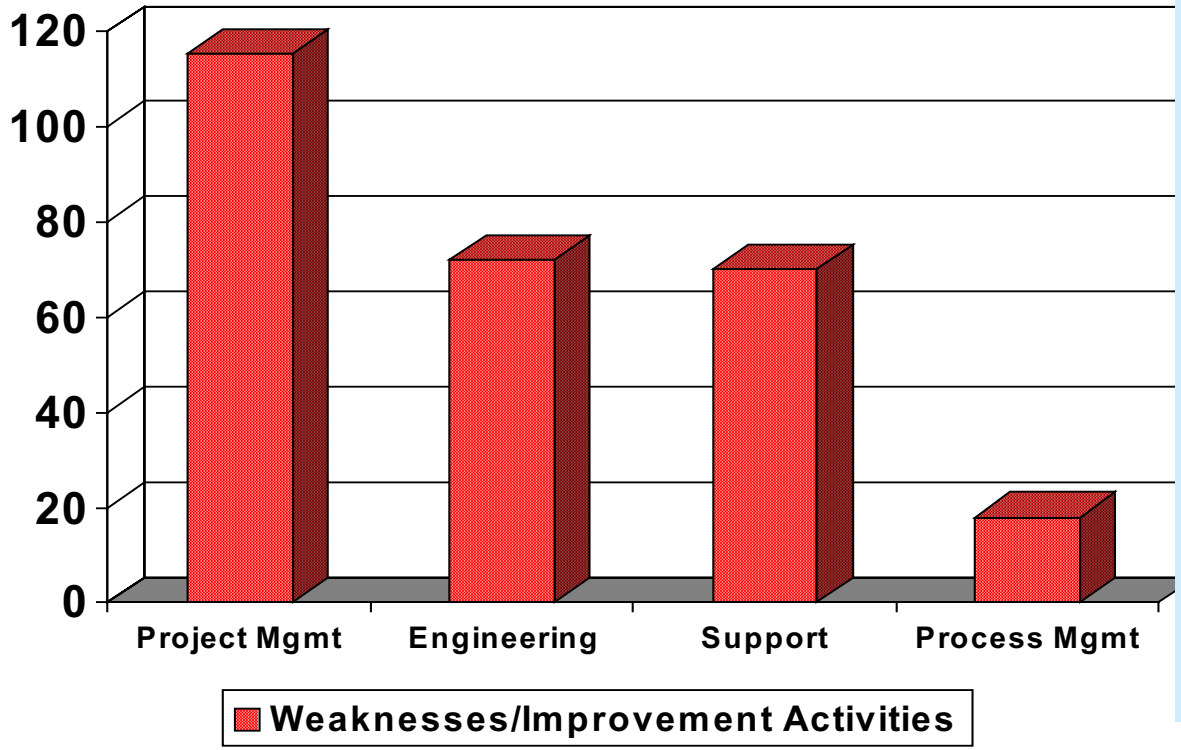
“Affinity Grouped” Weaknesses to correct systemic problems, not just symptoms

- For example: “Baseline” Management would combine findings from CM, RM, RD, TS, etc.

11 Risk areas / Process Improvement Categories identified

- Being used as the basis for project process improvement activities

Weakness Characterization by Process Grouping Across Program



Project Mgmt Processes:
- Project Planning
- Project Monitoring & Control
- Integrated Project Mgmt
- Risk Management

Engineering Processes
- Requirements Mgmt
- Requirements Definition
- Technical Solution
- Product Integration
- Verification (Peer Reviews)

Support Processes
- Measurement & Analysis
- Product and Process Quality Assurance
- Configuration Mgmt
- Decision Analysis

Process Mgmt
- Organizational Process Focus
- Organizational Process Definit

Issues Identified in Appraisals - Program Management

Use of corporate standard engineering processes on program
Lack of project plans or having only incomplete, conflicting or out of date project plans
Ineffective use of Integrated Master Schedule as basis for planning/tracking status across program
Undefined engineering and management processes on program
Inability to track and manage actions to closure
Cost estimation processes, methods, data and tools
Staffing and training project personnel
Tracking dependencies between or across teams
Managing project data
Ability to proactively identify and manage risks

Issues Identified in Appraisals - Engineering

Understanding of the program's requirements
Requirements traceability to architecture/design or to test plans/procedures
Linkage of functional and performance requirements
Inconsistent requirements management at different levels
Criteria for making architectural/design decisions among alternatives
Capturing entire technical data package (requirements, design and design rationale, test results, etc)
Efficiency of design process/methods
Defining integration and test procedures
Defining/maintaining integration and test environments
Existence of integration procedures

Issues Identified in Appraisals – Support Processes

Identifying items in configuration management baselines
Ability to manage individual “versions” in incremental development
Effectively managing changes to work products throughout lifecycle
Conducting audits to establish/ensure integrity of baselines throughout incremental engineering and development
Effectiveness/efficiency of change management process (cycle time, volume of changes)
Roles/responsibilities of change control boards
Quality Assurance audits of products and processes
QA involvement in system and software engineering processes
Sufficiency of resources for quality assurance/product assurance
Defining, storing, analyzing, using measurement data
Breadth of metrics to manage engineering activities (outside of cost/schedule data)

Progress In Action-Plan Implementation

Re-Assessed during subsequent appraisals (18 months later)

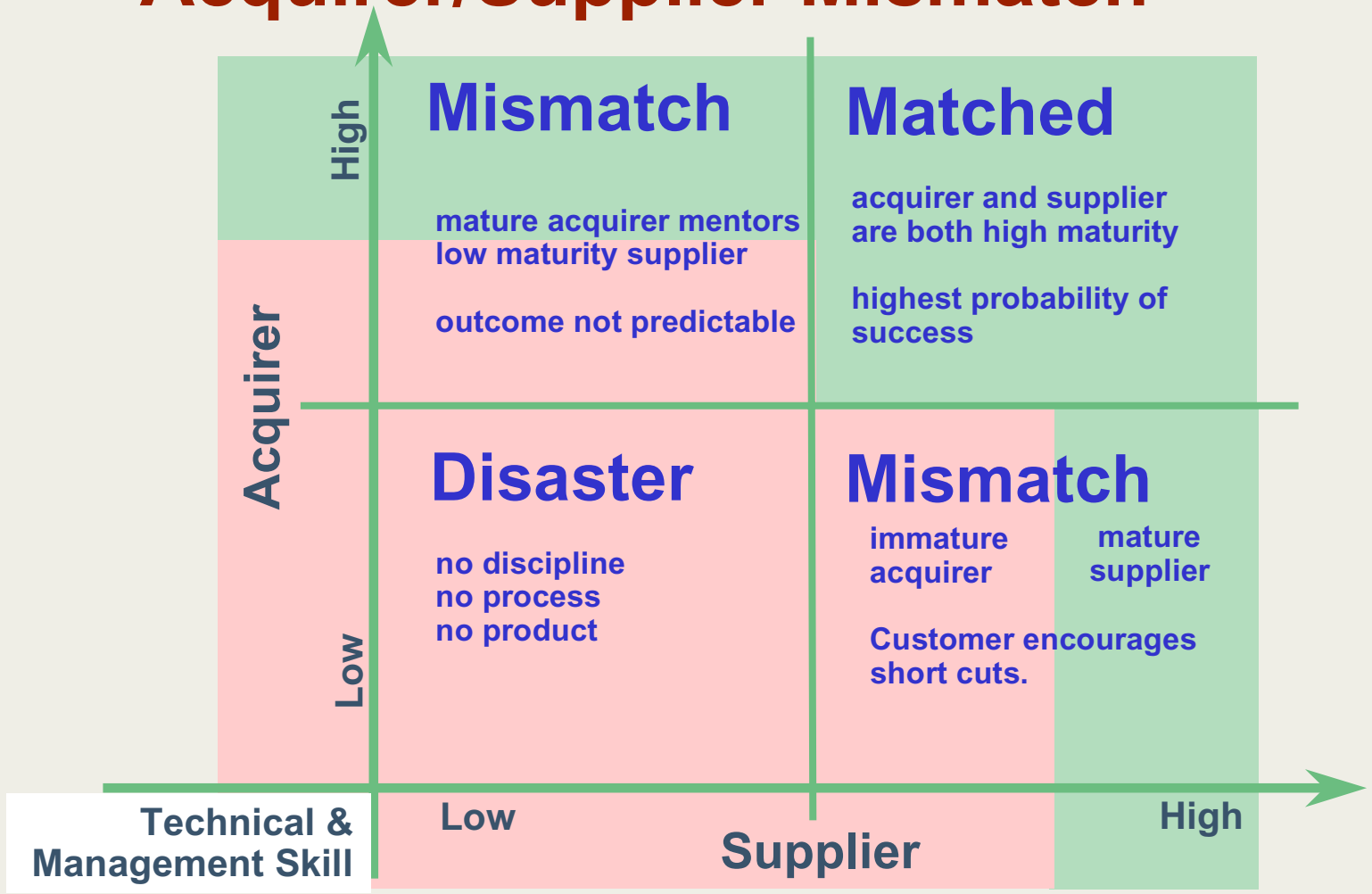
- Good News: Majority of issues addressed or completely resolved
- One program segment (prime and subcontractor teams)
  - 73 findings resulted in 41 Action Plans through affinity grouping
    - Thirty (30) were implemented within 6 months of appraisal
    - Additional eight (8) implemented within 9 months of appraisal
    - Final 3 resolved prior to return appraisal
  - Program Mgmt (contractor and gov't) briefed weekly on progress
  - Contractors gather "evidence" of process use and effectiveness
- Major Subcontractor:
  - 31 Findings resulted in 24 action plans
    - 24 corrected within 9 months of appraisal
- Additional Subcontractor:
  - 22 findings resulted in 22 action items
    - All 22 corrected within 6 months of appraisal

Bottom Line

In-progress reviews ensure the practices used by the entire team are effective

Early identification and mitigation of common process-related issues and problems

Acquirer/Supplier Mismatch



Some Acquisition Scenarios

Scenario 1: Acquiring a low-risk sub-component

Scenario 2: Acquiring subsystems

Scenario 3: Acquiring whole systems

Scenario 1 – Low Risk Component

Project X is building a mission planning system to manage the tasking of an earth observing sensor.

Subsystems include:

- Scheduling Subsystem
- Planning Subsystem
- Task Management Subsystem
- Reporting Subsystem
- Map Subsystem

The project has decided to procure a commercially available mapping system for their map subsystem. Multiple suppliers have adequate products that require minimum modifications for the purpose. The acquisition team would need to help analyze options, select a supplier, and manage the supplier agreement.

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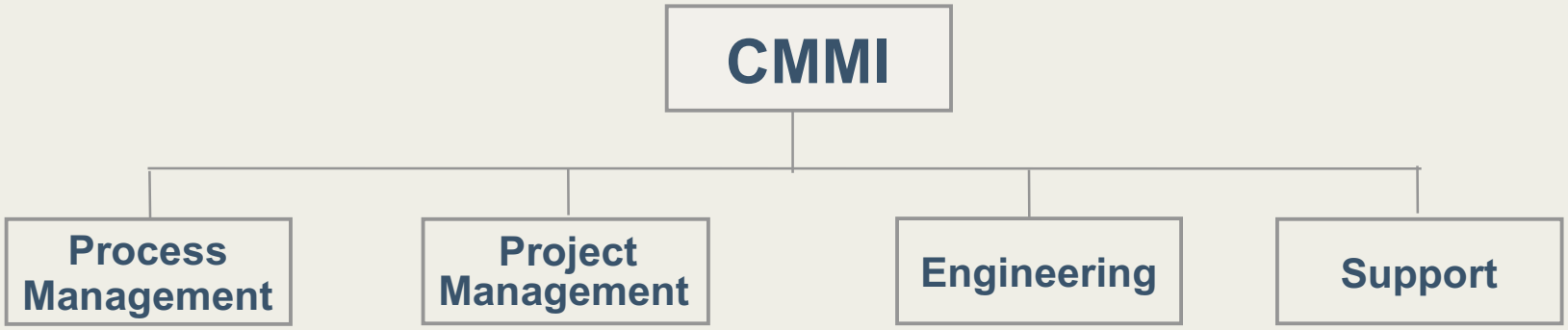
CMMI SE/SW



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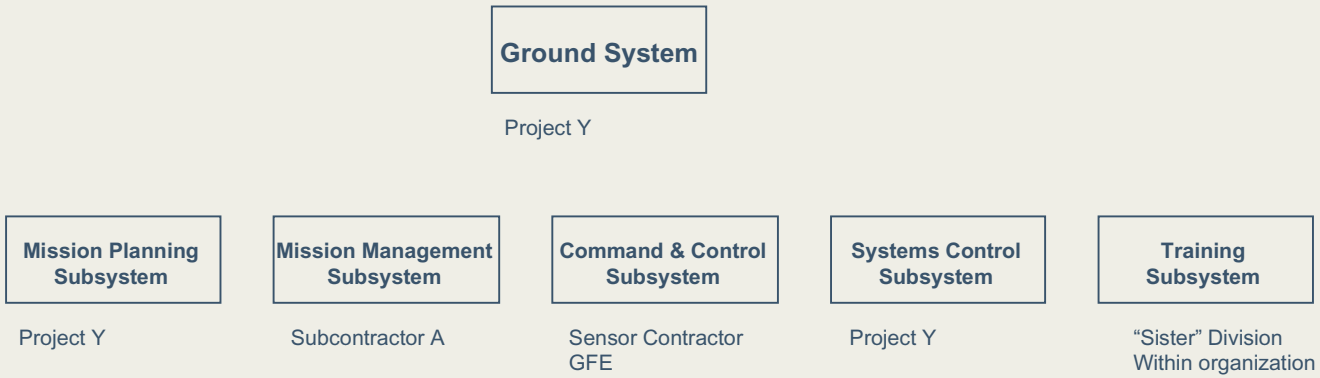
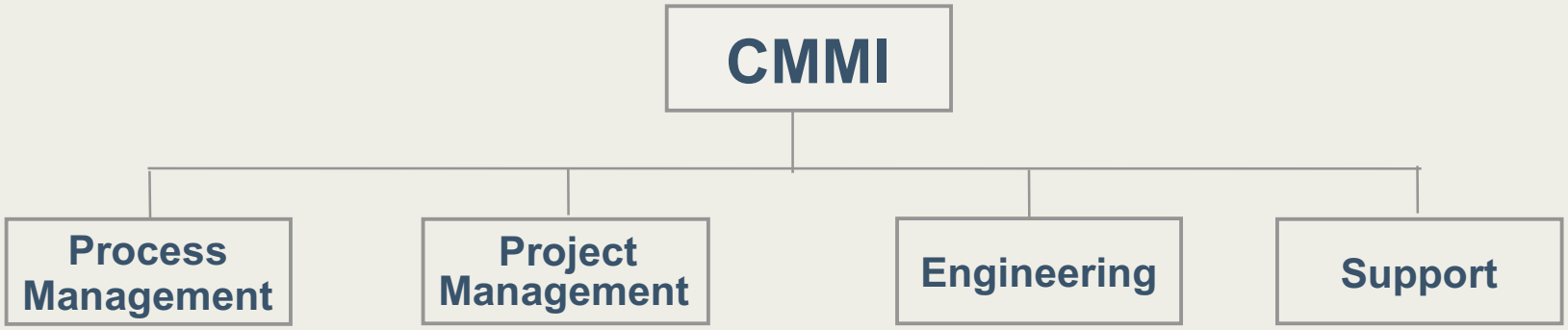
Scenario 2 – Shared Risk

Project Y is responsible for delivering an integrated ground system for a new earth observing sensor.



Success of Project Y is highly dependent on success of suppliers – risk of failure is high if any one of the suppliers fail – the project needs to proactively manage the supplier relationships.

CMMI SE/SW/IPPD/SS



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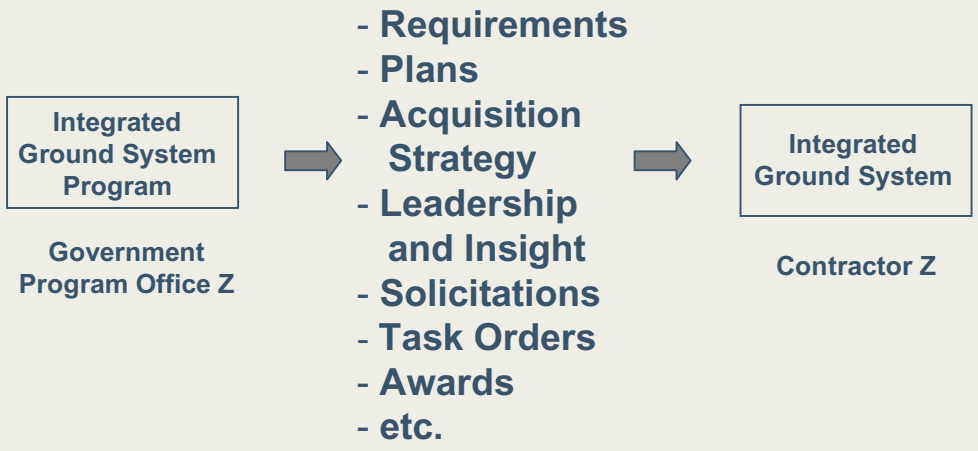
Scenario 3 – Acquiring Whole Systems

Project Z is an acquisition organization responsible for acquiring an integrated ground system for a new earth observing sensor.



Success of the government/contractor team is highly dependent upon success of both parties. High quality practices required on both sides.

Which Model to Use?

SA-CMM – Focus on acquiring a software system

Acquisition Module for CMMI (new) – Focus on system acquisition

Acquisition Module for CMMI

Focuses on effective acquisition activities and practices that are implemented by first-level acquisition projects (e.g., System Project Office/Program Manager)

Acquisition practices drawn and summarized from existing sources of best practices:

- Software Acquisition Capability Maturity Model (SA-CMM)
- Capability Maturity Model Integration (CMMI)
- FAA Integrated Capability Maturity Model (iCMM)
- Section 804

Intended to be used in conjunction with the CMMI as an acquisition “lens” for interpreting the CMMI in acquisition environments

Process Areas Included*

Configuration Management
Decision Analysis and Resolution
Integrated Project Management
Integrated Teaming
Measurement and Analysis
Organizational Environment for Integration
Process and Product Quality Assurance
Project Monitoring and Control
Project Planning
Requirements Development
Requirements Management
Risk Management
Solicitation and Contract Monitoring
Transition to Operations and Support
Validation
Verification

*Acquisition Module for CMMI expected publish date: mid Feb 04

Solicitation and Contract Monitoring

The purpose of Solicitation and Contract Monitoring is to prepare a solicitation package that identifies the needs of a particular acquisition, to select a supplier who is best capable of satisfying those needs, and to provide leadership throughout the life of the acquisition to ensure those needs are met.

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Solicitation and Contract Monitoring

The project is prepared to conduct the solicitation.

- Designate a selection official responsible for making the selection decision.
- Establish and maintain a solicitation package that includes the needs of the acquisition and corresponding proposal evaluation criteria.
- Establish and maintain independently reviewed cost and schedule estimates for the products to be acquired.
- Validate the solicitation package with end users and potential bidders to ensure the approach and cost and schedule estimates are realistic and can reasonably lead to a usable product.

Suppliers are selected based on the solicitation package.

- Evaluate proposals according to the documented solicitation plans.
- Use proposal evaluation results as a basis to support selection decisions.

Contracts are issued based on the needs of the acquisition and the suppliers' proposed approaches.

- Establish and maintain a mutual understanding of the contract with selected suppliers and end users based on the acquisition needs and the suppliers' proposed approaches.
- Establish and maintain communication processes and procedures with suppliers that emphasize the needs, expectations, and measures of effectiveness to be used throughout the acquisition.

Work is coordinated with suppliers to ensure the contract is executed properly.

- Monitor and analyze selected processes used by the supplier based on the supplier's documented processes.
- Evaluate selected supplier work products based on documented evaluation criteria.
- Revise the supplier agreement or relationship, as appropriate, to reflect changes in conditions.

Transition to Operations and Support

The purpose of Transition to Operations and Support is to provide for the transition of the product to the end user and the eventual support organization and to accommodate lifecycle evolution. Eventual disposal of the product should be considered.

Transition to Operations and Support

Preparation for transition to operations and support is conducted.

- Establish and maintain a strategy for transition to operations and support.
- Establish and maintain plans for transitioning acquired products into operational use and support.
- Establish and maintain training requirements for operational and support personnel.
- Establish and maintain initial and life-cycle resource requirements for performing operations and support.
- Identify and assign organizational responsibility for support.
- Establish and maintain criteria for assigning responsibility for enhancements.
- Establish and maintain transition criteria for the acquired products.

Acquired products are transitioned to operations and support based on transition criteria.

- Evaluate the readiness of the acquired products to undergo transition to operations and support.
- Evaluate the readiness of the operational and support personnel to undergo transition to the acquired products.
- Analyze the results of all transition activities and identify appropriate action.

Using the Acquisition Module

Guidance on establishing effective processes in a program office

Informal gap analysis

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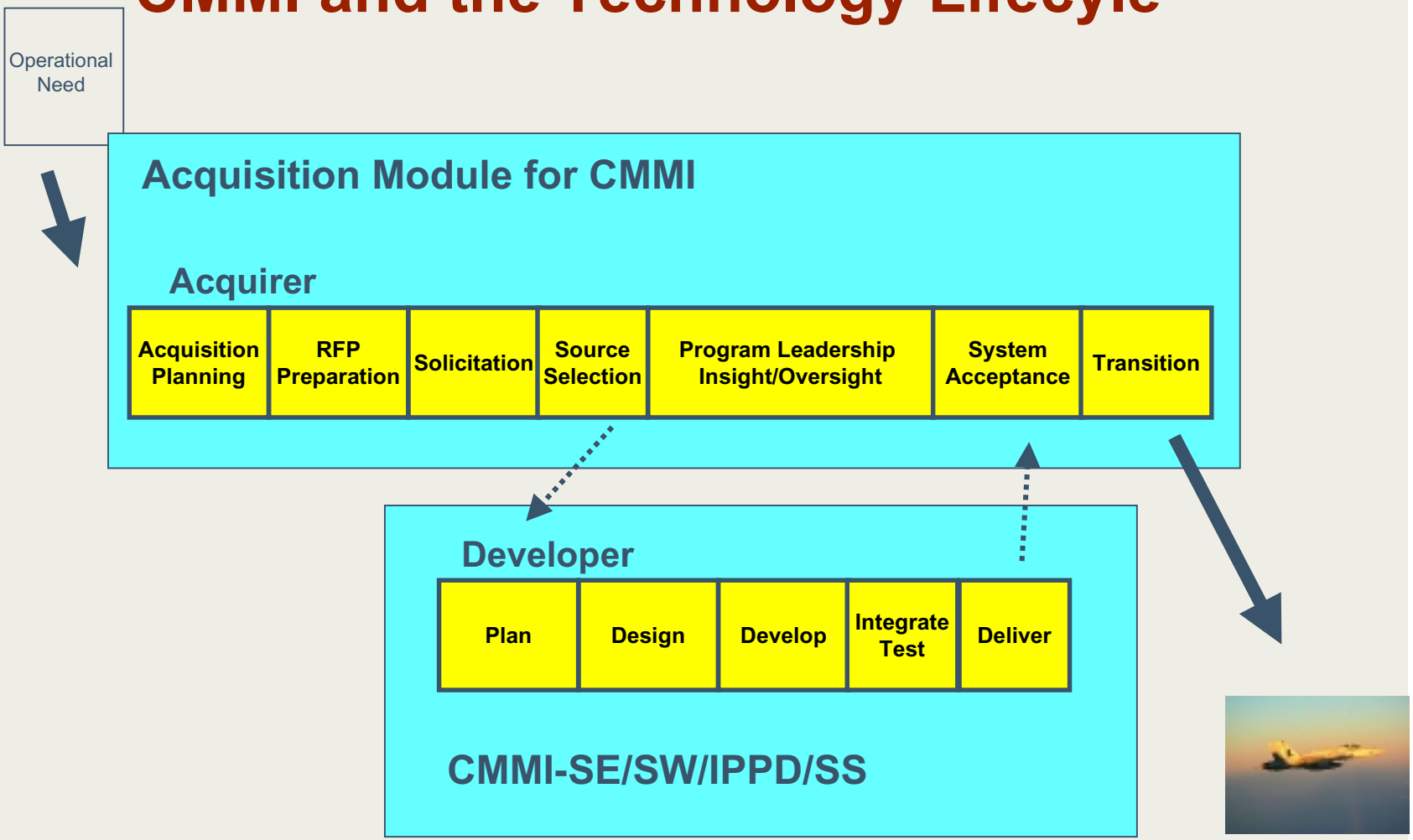
CMMI and the Technology Lifecyle



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